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ECONOMIC GROWTH, INNOVATION AND COLLABORATIVE RESEARCH AND DEVELOPMENT ACTIVITIES

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Abstract. *One of the most analysed business practices related to technology and innovation has been the coordination of the activities of rival firms and institutional bodies in Research and Development. This paper focuses on the analysis of the collaborative agreements in Research and Development. The paper is divided into two parts. The first part of the essay describes the terms of the Innovation, Research and Development, and cooperation activities, as well as their effects and importance to the successful course of the companies and the economy in general. The second part of the paper focuses on the beneficial role of innovative activities to the private business units and the market performance, enhancing, at the same time, the social welfare.*

Keywords: cooperation activities, efficiency, innovation, market failures, welfare.

1. Definition of innovation

In the last three decades, significant changes have taken place in the business environment all over the world. In today's globalised markets new businesses and corporations have emerged, trying intensively to find new investment opportunities and new channels for their products. These changing conditions have imposed a great number of challenges to organisations in every sector. Corporations seek to find new resources and opportunities to develop their capabilities and obtain a wider variety of organizational mechanisms to become and remain more competitive than their rivals. Firms in every industry, and especially those related with high technology, have found themselves struggling to acquire and accumulate new knowledge, apply it to their business, and then commercialise the newly produced technology adeptly and profitably.

This course is known as „innovation", a term which includes „the search for, discovery" development, improvement, adoption, commercialisation of new processes, new products, and new organisational structures and procedures and it is a process that involves uncertainty, risk taking, probing, reprobing, experimenting, and testing. Above all, innovation is a cumulative activity that involves building on what went before, whether it is inside the organisation or outside the organisation, whether the organisation is private or public, whether the knowledge is proprietary or in the public domain' definition given by Jorde and Teece (1989).

2. Significance of the innovative activities to the firms and the economy

2.1 Innovation and economic progress

Innovative technological progress is essential not only to business success, but also to the long run performance of the economy as a whole. A generation of theories represented by Romer (1986) take innovation as an endogenous variable which can explain the different national growth rates and why economies, even with different rates, do not converge to long-run steady state equilibrium. The reason is that the long-run productivity decrease is avoided, due to capital accumulation through the qualitative-technological improvements of natural and human capital. Innovative actions are considered to be rather important to economic growth, development and welfare. Firstly, they stimulate investments which introduce new commodities and processes, which improve the living standards of the society. Moreover, they lead to new developments, which increase the comparative advantage of an economy and affect positively the trade performance and competitiveness of a country worldwide. These effects result in a greater level of economic growth.

2.2 Innovation and corporate success

On the other hand, innovation is rather important to an individual firm for two main elements, that is it has a double role in the incentives of the companies to pursuit and invest on it.[1] Firstly, a corporation, which undertakes R&D programmes, acquires new information and knowledge to embody in the new commodities, as well as new production and marketing processes, ready to be employed in product and process innovation. As a result, through innovation, a company is able to develop directly new products and processes and bring them to the market acquiring an advantage over its competitors. Furthermore, it can enhance the ability of the firm to develop and maintain capabilities to absorb and expand technology information available by external sources, and identify, assimilate and exploit new knowledge and technology produced elsewhere. (Cohen and Levinthal, 1989)

3. Cooperative relationships in R&D

It is also often required that firms enter complex contracts and relationships in order to bring technological advances to the market and hold their competitors behind. Since most of the firms are not fully integrated, they tend to build bilateral or multilateral contracting agreements and cooperative relationships with rival firms, in order to commit to a common goal and access, create and diffuse technological knowledge, trying to exploit the benefits from cooperative manufacturing and

commercialising of research, to gain large-scale operation benefits and to take advantages of sharing the associated risks.

The range of inter-firm agreements bearing to some degree on technology is considerable. Co-operation and exchange of technology among firms and/or other research organisations can take place at a given point of R&D and/or commercialisation process, or cover the process as a whole and it may refer to the creation or just acquisition and use of knowledge. These agreements are quite flexible in their formation and they may take place among firms of equal or different size, financial strength, and market power, universities, government agencies, and laboratories.

The two following tables present the range of agreements which firms may establish to produce, acquire, and commercially exploit technology in common, both in pre-competitive and competitive stage.

Table 1

Research and Development Cooperation in the Pre-Competitive Stage

A	B	C
University based co-operation research financed by associated firms (with or without public support)	Government-industry co-operative R&D projects with universities and public research institute involvement	Research and development corporations on a private joint-venture basis
Many Partners	Many partners	Several partners

Table 2

Research and Development Cooperation in the Competitive Stage

Technological cooperation			Manufacturing and/or marketing co-operation		
D	E	F	G	H	I
Corporate venture capital in small high tech. firms (by one or by several firms otherwise competitors	Non-equity co-operative research and development agreements between two firms in selected areas	Technical agreements between firms concerning completed technology, technology sharing agreements; second-sourcing agreements; cross-licensing in separate product markets	Industrial joint venture firms and comprehensive R&D, manufacturing and marketing consortia	Customer-supplier agreements, notably partnerships	One-way licensing and/or marketing agreements (including sales agreements)
Few or very few partners	Few or very few partners	Few or very few partners	Few or very few partners	Few or very few partners	Few or very few partners

4. Market benefits from R&D cooperation

4.1. Innovation and market failures

Although firms have several reasons for investing in R&D, free market powers are still not sufficiently effective in providing the socially optimal level of innovation, in the form of R&D investment expenditure in an economy. This happens because investments in R&D differ from regular capital investments in two main features:

1. R&D has the characteristics of a public good.[2] Information produced by the R&D investments of a firm may be used, not only by the innovative firm, but it is also available to other firms.

2. R&D investments face the problem of externalities. R&D activities are substantially characterised by externalities or spillovers, which means that the R&D results of an innovative leading firm may flow to other firms, without any compensative payment to the firm which innovated first. Firms which invest in R&D cannot appropriate the complete results of their investment expenditures, and this leads to the reduction of the private firms' incentives to innovate.

These two main features associated with innovation actions discourage private corporations from undertaking R&D investment projects, putting an obstacle in the firm, as well as the economic progress itself.

The formation of cooperative research organisations may be a remedial measure in providing optimal levels of knowledge, retain and promote efficiency. Through collaboration the companies may preserve a more competitive output market structure and alleviate the motivation shortcomings that appear in the provision of a public good. With this development, corporations are more willing to join forces and assets to engage themselves into an R&D program, relative to the research rivalry case, since they are able to achieve a more efficient outcome, avoiding spillovers and unnecessary duplication of effort problems, and permitting the smooth dissemination of technology and information, beneficial for the industry and the market altogether.

4.2. R&D cooperation as solution to market failures

4.2.1. Spillovers in the technology and innovation generation

A spillover, or an externality, occurs when the investment activity of one business benefits, (positive externality), or burdens, (negative externality), another firm which is not part of the activity.

During decision making about its R&D expenditure level, a corporation takes into consideration the effects of its decision upon its competitors. If there are spillovers and competitors may have free access to positive externalities which reduce their production costs and increase their productivity, their competitive position will

be strengthened by taking advantage of these leakages. Firms which undertake R&D investments are, in case of spillovers, unable to appropriate the complete benefits of their activities. This lack of full appropriability may influence negatively the desirability of R&D investment undertaking.

In this case, cooperation represents a solution to spillover problems of R&D leakages and help firms to overcome the socially inefficient level of investment by giving them the opportunity to undertake R&D which is highly inappropriable and which firms would be, otherwise, disinclined to support individually, by helping them to internalise the corresponding leakages. Through cooperation, participants are forced to pool R&D costs and commit to certain investment expenditures ex ante, that is before R&D is undertaken and the R&D results become available, and before any spillovers appear. The larger the degree of commitment of the venture members, the more sustainable the cooperation, and the greater the amount invested on R&D, since sharing of information among innovators becomes more efficient and any positive leakages are internalised across the participants, which leads to an increase in the incentives to undertake R&D investments. This effect is rather important in markets in which there are weak intellectual property rights and intense technological spillovers, which lead to a low degree of knowledge appropriability, as well as a low degree of innovation supply.

4.2.2. Duplication of research effort and investment

In the run of an innovation race, there is a great deal of possibility that individual firms in the same or similar industries which undertake R&D activities independently may follow identical or similar technological and research paths, which result in meaningless duplication of R&D efforts and needless wasting of resources. This result may be minimised or even eliminated and economising on scarce R&D resources will be realised, if R&D plans and research efforts are centralised and coordinated.

Coordination through cooperation may improve the efficiency of the combined projects and reduce the duplication of effort. As Grossman and Shapiro (1987) argue, cooperation assures that all the partners are able to have access to any intermediate and final results of their combined R&D effort. Consequently, there is no need for any participating firm to duplicate the research activities in order to access knowledge already achieved by rival firms.

4.2.3. R&D dissemination

The problem which arises in joint research activities in a free market, as examined by Bhattacharya et al. (1990), is the incentive of an individual firm to reveal its abilities to others, when partners are not informed about each other’s technical capabilities. Partners, in most of the cases, try to get as much as possible from their

partners and at the same time, they try not to give away their own competitive advantages. They appreciated the importance of sharing technological expertise in R&D activities and noticed that appropriating other firms' intangible assets, such as expertise, technological and organisational knowledge, might well be an objective of undertaking joint R&D activities. Joint R&D efforts are more widely disseminated than those conducted individually. Ex ante cooperation in innovation projects increases their efficiency, because a single investment, once acquired, benefits more than one firm and makes new knowledge and information an asset common to all the cooperation members.

5. Business benefits from R&D cooperation

As discussed above, cooperation has positive implications not only for the market as a whole, but also for the individual firms. These positive effects can be viewed below under the headlines economies of scale, decreased firms cost, risk and cost sharing.

There is little doubt that they are rather important sources of success for an individual business unit, since it is able to achieve objectives that were not possible before the agreement. On the other hand, collaborative R&D relationships include several seriously problematic features and introduce costs that were not present when the participating business entities were independent, inhibiting the success of the collaboration.

These difficulties range from communication and contractual problems to differing objectives of the participating firms. In particular, when previously separate organisations are brought under a common central management in a field, here in R&D, there are problems arising related to the fact that these participants are not homogenous, but actually different. This means that they have different perspectives as far as concerned with the R&D process, the aims, the needs, and the techniques and procedures that should be employed. There are obviously major problems involved in attempting to combine different organisations with their own differing business histories and background, their own systems of operation, their own reporting and control methods.

Furthermore, since firms are under a common management in R&D procedures, it implies that each member has the power to intervene in the decision making and planning and influence them according to its interest and goals. This introduces important difficulties in managing and especially sharing the results and the benefits of joint research. The most serious challenge that cooperation has to face is the potential principal – agent problem. Venture members are supposed to combine their research forces to benefit from any complementarities in their assets. That is why they agree on exchanging their expertise and knowledge. In reality, this is not always the case. Collaborators have fears that rivals could benefit more from the collaboration, so as to increase their competitiveness on the product market, obtaining a larger market share and increased profits. That is why firms, especially the ones with

higher innovation accumulation, are reluctant to share their knowledge and information with the others. On the contrary, they try to take things from the venture, giving as little as possible to their associates. This attitude not only does not promote the cooperation's aims, but also it works on its destruction. In addition, when it comes to distribution of the results or other research benefits among the member firms, there is a great degree of possibility that some or most of them will try to influence the decisions according to their benefit, bringing conflicts and hostility among the partners, which makes the venture considerably unstable.

5.1. Attainment of economies of scale

Through cooperation, participants who possess complementary tangible and intangible assets, such as experience, information, technological resources and expertise, and teams of qualified researchers and personnel, are able to bring their complementary resources, skills, and expertise together. As Katz and Ordover (1990) say, through the combination of their actions, each partner firm will be assigned the activities in which it is more efficient, and this specialization will reduce the cost and increases the productivity of the project. By this combination they may take advantage of economies of scale and synergetic effects created in their joint R&D investment programmes and affect their R&D abilities.

5.2. Decreased firm cost

Cooperation activities may significantly contribute in increasing the profits of the participating firms by decreasing its production costs. Cooperation creates a new business unit which represents all the member companies. This unit can buy or sell operations in large-scale and exploit resources in large volume, realising economies of scale and increasing efficiency in every aspect of development and production operations. Moreover, joint activities may improve the cost side of a business. When research is undertaken by cooperation the cost of production is decreasing not only directly due to better transaction and production conditions, but also indirectly, by decreasing the cost of subsequent development research undertaken by the individual firms members of the research joint venture.

5.3. Risk and cost sharing

R&D programmes are usually characterised by a high degree of uninsured risk and uncertainty in the demand of their output. Due to these features, namely, high levels of risk and uncertainty and high rates of failure, R&D investments are not particularly favourably treated by the capital market, which require a high level of interest compensation in exchange for financing these projects, making it almost unprofitable to the private corporations to use the capital and credit markets to spread

the risk and cost of their investments. This problem is not only faced by small and medium corporations, which do not posses the necessary funds. Even large and very large companies do not have the adequate and necessary resources to undertake projects for the development of new technologies independently, so the most apparent thing to do is to conduct R&D in collaboration with other firms. Cooperative research relationships may provide a solution to these restrains, since it has been widely recognised that cooperation activities have the ability to be utilised as a way to overcome imperfect financial markets and raise capital to fund large R&D projects.

6. Social welfare effects

6.1. Positive social welfare effects

Innovating firms, by forming R&D alliances and by spending jointly on R&D may enhance the possibility of improving the quality of their product and increase social welfare, relative to the non-cooperative case. Society is benefited by cooperative R&D alliances, because on the one hand, by undertaking joint investments, associated risks and costs are shared among the participants, so each firm's R&D incentives increase. On the other hand, the technological progress is stimulated by the sharing of information, knowledge, and expertise among the collaborators, making them able to exploit their capabilities better, combining them with complementary assets possessed by other firms. Furthermore, in order to acquire a competitive advantage, firms devote their efforts in the use of new technologies and the supply of new products, which increases the post-innovation competition in the market level, leading to lower prices, higher product quality, and larger variety, increasing the consumer surplus and enhancing the social welfare, a process beginning from the cooperation activities formation.

6.2. Negative social welfare effects

As discussed above, ex ante collaboration refers to joint undertaking of R&D activities among competitive firms, mainly through the formation of cooperation activities. The range of a collaborative agreement varies and can be expanded not only to the research field, but also to the product market. So, there are arrangements in which cooperation is limited only to undertaking a specific R&D project, regarding the sharing of costs and products of the research effort, without any further pledges, preserving the competition among the participating companies in the product level. There is also another case, in which the firms' collaboration may be expanded also in the product level. Apparently, one of the main features of cooperative R&D ventures is that they set the potential gains from internalising technological spillovers and positive externalities against the potential costs of a reduction in competition in the

market of innovative commodities and there have been concerns about whether the creation of cooperation is desirable from a social welfare point of view.

Since participants have combined their activities under a common control, it is possible that they exercise their combined force and curtail, resulting in restraining their R&D effort and competition in other stages of their connections, arising speculations about the outcomes of competition in final product markets. As Katz and Ordover (1990) say, once a group of firms has innovated successfully and has brought advanced products and processes in the market, it acquires a certain degree of bargaining command over the rival firms and it can exercise oligopolistic or even monopolistic power, bringing pricing distortions in the market for R&D results. Firms which participate in collusion including price and output levels, may behave as a monopoly, they limit their investment and set lower output and higher prices in a way to maximise their aggregate profits, which leads to a decrease in social welfare.

To the extent in which collaborating firms establish oligopolistic or monopolistic power, and the research collusion is extended to the subsequent product market, cooperation activities may be exploited as a part of the business strategy of the participants and create well-defined strategic groups which pressure to decrease the incentives to invest, putting non-member firms at a competitive disadvantage by limiting spillovers of new information to competitors.

The R&D achievements and the corresponding competitive advantage, which is obtained by the venture members through their collaboration, may be also utilised as a strong entry barrier or even a legal block, if the cooperation innovations are under patent authority protection against the potential entrants to the industry. Technological knowledge and information makes the venture members more efficient and competitive relative to the competitors in their industry. Moreover, the high investment expenditure undertaken by the venture also raises the entry costs for any potential entrant, and makes it difficult for them to enter the market.

7. Conclusion

This paper was an attempt to provide an analysis of the cooperation activities as an element of innovation generation. As becomes fairly apparent by the analysis in this paper, there are certain problems in knowledge generation and diffusion, which prohibit the free market mechanisms from working efficiently and result in a situation in which the private level of innovative activity divergences from the social optimum standard, resulting in the so-called ‘market failures’. As a consequence, there is need for certain technology policies and actions, in order to deal with this problem and improve the market operation. Cooperation activities may well be one of these policies, as shown earlier in the paper, since they can limit the negative effects of spillovers, duplication, and inefficient dissemination. Apart from that, we showed how cooperation may help individual firms to undertake R&D projects, which are usually characterised by high cost and uncertainty. Through R&D investments, firms are able to improve their products and/or productive processes, improving their efficiency and

acquiring a comparative advantage over their rivals, explaining the significance of cooperation as a strategic trade policy tool, domestically and internationally.

Through the discussion about the beneficial effects of cooperative research ventures, the reader of this paper gets the notion of the importance of such cooperation in the market and business performance. This, of course, does not mean that there are no negative effects, or that cooperation is an efficient tactic under any circumstances. Problems such as the great level of instability of cooperation as a result of the principal – agent problem, the high transaction and negotiation costs of collaborative agreements, and most importantly for the economy as a whole, the restrictions in competition imposed by collusion among rival firms which can be easily expanded not only in the production, but also the product market, demand a closer and more cautious look at these agreements.

Nevertheless, this paper, even though it surely recognises these cooperation's drawbacks, asserts that their positive effects are rather compensative for any problems and inefficiencies generated by R&D partnerships. Without these R&D relationships, it would be rather doubtful whether certain R&D related market failures could be overcome, or whether individual business organisations could achieve R&D objectives and generate a substantial R&D level, capable of increasing the social welfare, bringing efficiency and growth to the market.

Cooperation activities are now considered as strategic-trade competitive methods, essential for most companies in almost every industry in supporting their international competitiveness. A continuously increasing number of corporations in every economically developed country use such strategic technological alliances, and especially cooperation activities, to create, access, and diffuse technological knowledge. The antitrust environment has now become more eased and permits organizations to come into strategic associations to counter the force of the increased international competition and the rapidly changing technologies through the expansion of pre-competitive and infrastructural R&D. Taking into consideration the emergence of global markets, cooperation activities should be dealt not as a national, but a rather international matter, demanding and deserving direct support in finding an appropriate and effective strategy for today's deep changes.

International technological policy should move towards a new path to build economic effectiveness and stimulate economic growth, supporting both basic science and strategically oriented research. In addition to the creation of new technologies, particular consideration should be dedicated to the diffusion of existing knowledge and innovations focusing on the ability of the firms to locate, access, adapt, and use new technologies. This development could be of collective nature, incorporating industries, government authorities, universities, and research institutes, through interactive relationships, to assist the authorities to engage in the needed technology policy goals.

Concluding, it is believed that such an approach will result in more efficient and sufficient innovation generation levels, and can be rather beneficial for the business units and the overall economy. The suggestion made could be summarised in

the view that cooperation activities should be treated as a core technological and trade policy mechanism, accompanied by special policy considerations concerning any problems and drawbacks which may arise in their application.

Notes

[1] Cohen and Levinthal (1989) called this double role of innovation 'dual role'.

[2] Arrow (1962) analysed on the consequences of positive externalities associated with private investments in industrial R&D. In case of technological leakages to competitors, the solution applied by the market economies is the assignment of intellectual property rights. The issue raised is that, since information is an intangible asset, it cannot be completely appropriated and leakages are inevitable due to embodiment of knowledge in commodities publicly commercialised and the mobility of research personnel among firms. Consequently, due to these leakages, the incentives for innovation investments decline, under a socially desirable level.

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